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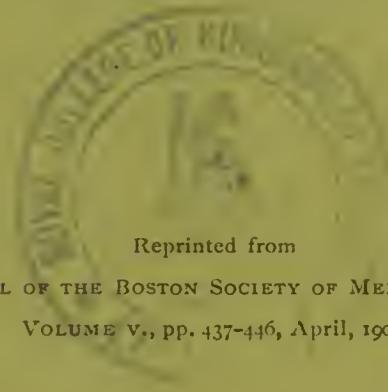
THE RELATION

BETWEEN

PHYSIQUE AND MENTAL WORK

(SECOND PAPER)

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THE RELATION BETWEEN PHYSIQUE AND MENTAL WORK.

(Second Paper.)

HENRY G. BEYER.

During the winter of 1899 I engaged in some studies regarding the relation existing between certain physical dimensions, and mental examination-marks obtained from some eighty-five navy yard apprentices, varying in age from fifteen to seventeen years. The results of these studies, which were published in February, 1900, in Vol. IV., No. 6, of this Journal (1), were of such importance as to make it seem desirable to extend the observations on a large number of school children, if possible, with the view of testing the correctness of the conclusions that were reached at that time, but from a comparatively speaking small number of boys. The work seemed especially promising for the reason that we were already in the possession of growth-tables of the children of Massachusetts (2), and because the existence of these tables permitted us to employ the same method of investigation as had been employed in similar work during the preceding year.

This method, as some of you may perhaps remember, consisted in attaching to each boy, instead of the absolute height, weight, etc., the percentile rank or value to which these measurements would correspond, and which is easily found on the tables mentioned, before making the comparison between the physical and mental marks. The method seems to be especially valuable for the reason that it introduces a certain very desirable element of homogeneity into the comparison between the physical and mental grades of children. Both stand for the fact that a child has attained so many points out of a possible one hundred, in both its physical and mental examinations. The method, therefore, puts both physical and mental examination-marks on a percentile basis, and hence must lead to a comparison from which, to say the least, results more striking may be expected than those obtained by former methods.

An opportunity for obtaining a number of measurements of children varying from ten to thirteen years of age, and belonging to the schools of Cambridge, Mass., was afforded me last year through the kind intervention of Prof. D. A. Sargent, who not only obtained for me the necessary permission from the school authorities of Cambridge, but also allowed me to engage the services of some of his advanced pupils in anthropometry to do the necessary weighing and measuring. My thanks are therefore due Professor Sargent for both these concessions.

Desirable as it would have been to obtain the chest circumference in addition to height and weight, the circumstances did not seem favorable enough, and thus it happened that our observations must be limited to height and weight alone. In working up the material, as will be seen in the tables, the boys and girls are treated separately. The cards belonging to each were classified, first, according to the age, as calculated from the nearest birthday, and second, according to the different school grades through which the children were found distributed. This having been done, the absolute height and weight noted on each card were converted into percentile grade values, in accordance with the growth-tables of H. P. Bowditch, and the various values added together, their sums averaged and tabulated. The results are exhibited on Tables I and II.

TABLE I.

AGE NEAREST BIRTHDAY.	Grade.	Number Examined in Each Grade.	PERCENTILE RANK.		AVERAGES.	
			BOYS.		Height (in.).	Weight (lbs.).
Years.						
10	3	10	53.5	39.0	61.05	55.00
	4	50	50.1	46.1		
	5	54	62.9	54.6		
	6	34	74.7	67.2		
	7	7	77.8	68.5		
	9	1	100.0	100.0		
		— 156				
11	2	1	20.0	20.0	53.20	50.10
	3	16	36.5	38.1		
	4	101	45.5	44.9		
	5	145	55.0	50.0		
	6	128	56.9	54.3		
	7	36	58.4	53.3		
	8	7	66.6	54.2		
	9	2	90.0	95.0		
		— 436				
12	2	1	20.0	20.0	50.60	48.00
	3	14	30.7	38.2		
	4	65	39.6	44.5		
	5	104	41.8	41.1		
	6	130	55.1	49.5		
	7	94	55.2	49.0		
	8	30	69.0	58.6		
	9	15	79.0	74.0		
	10	1	20.0	80.0		
		— 454				
13	3	5	22.0	24.0	44.00	45.00
	4	24	33.5	34.5		
	5	60	41.2	41.5		
	6	73	41.7	41.1		
	7	71	50.1	46.5		
	8	49	60.2	56.0		
	9	24	56.0	46.2		
	10	9	64.4	58.3		
	11	2	85.0	65.0		
		— 317				
		Total, 1,363				

TABLE II.

AGE NEAREST BIRTHDAY.	Grade.	Number Examined in Each Grade.	PERCENTILE RANK. GIRLS.		AVERAGES.	
			Height (in.).	Weight (lbs.).	Height (in.).	Weight (lbs.).
Years.						
10	4	58	55.0	59.0	73.6	74.1
	5	47	60.5	72.5		
	6	48	77.6	71.4		
	7	5	85.0	68.0		
	8	1	90.0	100.0		
		— 159				
11	3	22	34.7	39.0	53.2	54.8
	4	113	37.4	40.5		
	5	132	44.4	46.0		
	6	97	57.1	57.3		
	7	60	71.0	67.0		
	8	10	75.0	79.0		
		— 434				
12	4	60	40.2	38.1	51.4	50.2
	5	108	44.7	44.4		
	6	128	44.5	41.0		
	7	117	49.2	49.2		
	8	39	58.9	57.9		
	9	13	71.1	71.1		
		— 465				
13	4	28	31.6	34.4	43.5	44.0
	5	45	32.8	37.6		
	6	86	40.3	40.4		
	7	82	46.3	47.6		
	8	59	48.1	44.2		
	9	31	62.4	60.0		
		— 331				
		Total, 1,389				

These tables show an almost unbroken increase in percentile rank of both height and weight among children of the same age, as we follow the different columns from above downward or from the lower to the higher school grade.

This fact is even more strikingly seen when comparisons are made between individual examination marks instead of whole grades and percentile grade marks, providing, of course, that children of the same age are used in such comparisons. This, however, could not be carried out without unduly increasing the number of tables that would become necessary in order to exhibit the results.

It seems, then, a clearly established fact that the amount and quality of intellectual work done by children is directly proportional to the percentile rank in their physique. So far as our own observations extend, this is true of children from ten to seventeen years of age. Whether this is equally true for adults is a question still awaiting further investigation.

Since the publication of my first paper, two articles on similar subjects have come to my notice. One is by Prof. William W. Hastings (3), who studied the heights and weights, in their relations to the school grades, of some Nebraska children aged eight to eleven years. The other is by Dr. W. S. Christopher (4), whose opportunities gave him a wide scope, for he included in his observations height, weight, strength of grip, ergographic tests for endurance, vital capacity, and hearing.

The conclusions of both Professor Hastings and Dr. Christopher are, in the leading points, identical with those I expressed in a former paper. Christopher says, on page 25: "It is clear from the foregoing charts and tables that on the average those pupils who made great intellectual advancement on the whole are taller, heavier, stronger, possessed of greater endurance, of larger breathing capacity, than those who have made less advancement." He also makes a note of an interesting fact observed by myself several times in connection with this work. He says: "In every school there are a few pupils who are small in stature and light in weight,

and yet exceedingly bright in their school work," and he considers these as constituting a class by themselves and deserving special consideration. An interesting example of this class may be seen on Table I., under twelve years. We will find under that head one boy in the second grade and one in the tenth grade, both of the same percentile grade in height, namely, twenty. When, however, we look at the column of weights we find that the tenth grade boy belongs to the eightieth percentile grade, while the second grade boy belongs to the twentieth percentile grade. This instance would perhaps, again, serve to emphasize the importance of weight at that age, to enable a child to keep up with the procession in school.

In the two columns of averages on both Tables I. and II. we will notice a sort of paradoxical decrease in the average percentile rank for both height and weight, as we follow them from the tenth to the thirteenth year, or from above downward. This decrease in the average percentile rank noted as we proceed from the younger to the older children is very significant and can, so far as I can see, be explained by the fact that the numerical proportion of the exceptionally tall, heavy, and bright boys and girls to the mediocre ones becomes less great as years go on, brought about, apparently, through the influence of mental training exerted upon the latter class of children. For when we calculate the averages of the different grades regardless of age, we again obtain an increasing series of physical rank as we proceed from the lower to the higher school grades, the same as when the classification was made according to age, as may be seen in the following Table III.:

TABLE III.

Grades. All Ages.	PERCENTILE RANK.	
	Height.	Weight.
3	35.67	34.82
4	42.17	42.50
5	50.22	46.80
6	57.10	53.00
7	60.37	54.32
8
9	81.25	78.86

Another possible explanation for this decrease in average might perhaps be found in that the bright and tall boys pass on to higher grades so quickly as to leave the lower classes with a lower and steadily decreasing average, from year to year, so far as physique is concerned.

However that may be, the principal conclusion arrived at in one of my former papers, namely, that physical and mental qualifications are directly proportional and generally found associated in growing school children, has again been found to be true. The great ease, moreover, with which it can be demonstrated in any number of children, whether large or small, would certainly predispose one to assume that a causal relationship exists between physical and mental qualifications. Added to this the further fact that we can increase the height, weight, lung capacity, and strength through a carefully graded and scientifically supervised system of exercises, over and above that amount which would result without such exercise, the whole subject of physical training assumes at once an enormous importance, stands at once in a truer and clearer light, and on a much firmer and much more solid foundation than ever before.

Before, however, we pronounce the existence of a relationship between physique and mental work as one of cause and

effect, let us look at and examine another side of the question. So far we only have shown this relationship to exist in growing children, and we therefore do not know whether it holds true for adults. Nor have we yet even thought of studying or investigating the possible influence of mental training upon the physique of our children. We have generally assumed that mental training, especially when it is overdone, is inhibitory to sound physical development. Might it not also be true that physical training, when it is overdone, might dwarf mental development? Could it perhaps be possible that the relation between physical and mental development is one of reciprocity? That the careful and proper development by the training of one must exercise a favorable reflex influence upon the development of the other? Have we anything that would even suggest the possibility of mental training such as our children get in schools, influencing favorably the development and growth of their bodies?

While thinking about this subject, it occurred to me that one of the means of approaching the problem with a chance of getting some light on it would be to compare the growth curves between boys who went through the high school and into college, and those who did not, beginning after both left the grammar schools, at the same time selecting a class of boys in whom no other essential differences as regards environment and other hygienic conditions exist; in other words, boys in whom the superior mental training which they get in the higher schools can be said to constitute the chief, if not the only, difference influencing their lives and growth.

An approach to such a condition may be found in the difference in the training of naval cadets on the one hand, and naval apprentices on the other. Both classes of boys start about the same age; their work on board ship as well as their drills on shore are almost identical; the food which they get has about the same value in calorics, the difference being that the cadets are served better than the apprentices (5); both get at least eight hours' sleep; the cadets do about the same amount of work with their hands as do the apprentices; in fact, we have here the rather rare opportunity of comparing

conditions of life in which the superior mental training received by the cadets at the naval academy may be said to constitute the chief, if not the only, difference. Consequently their respective growth curves, when compared to one another, ought to give some very valuable information with regard to this point.

The necessary material for such curves was found, partly in the growth tables published by me in 1895 (6), partly in tables not yet published, and compiled from the physical examination records of a large number of naval apprentices and landsmen for training.

TABLE IV.

Mean Values, Derived from 4,541 Cadets and 3,445 Men and Boys, Compared.

AGE.	HEIGHT (in.).		WEIGHT (lbs.).		CHEST CIRCUM. (in.).	
	Cadets.	Men.	Cadets.	Men.	Cadets.	Men.
15	64.29	63.37	108.50	109.00	29.95	30.07
16	65.80	64.01	116.90	114.42	31.10	30.40
17	67.00	64.87	124.80	122.60	31.89	31.34
18	67.63	65.43	131.80	124.94	32.68	31.80
19	67.65	65.68	137.00	128.45	33.25	32.00
20	68.25	65.84	138.50	133.90	33.58	32.50
21	68.21	66.10	138.90	134.90	33.65	33.14
22	68.35	66.31	138.70	140.08	33.77	33.62
23	68.52	66.45	138.30	140.85	33.87	34.00

The adjoining Table IV. exhibits the differences in the mean height, weight, and chest circumference between the two classes of boys. On examining the several columns in this table, we will notice, so far as weight and chest circumference are concerned, the apprentices have a slight advantage over the cadets, beginning, as they do, with a somewhat higher mean in both. As regards height, the cadets would seem to have a more decided advantage over the apprentices,

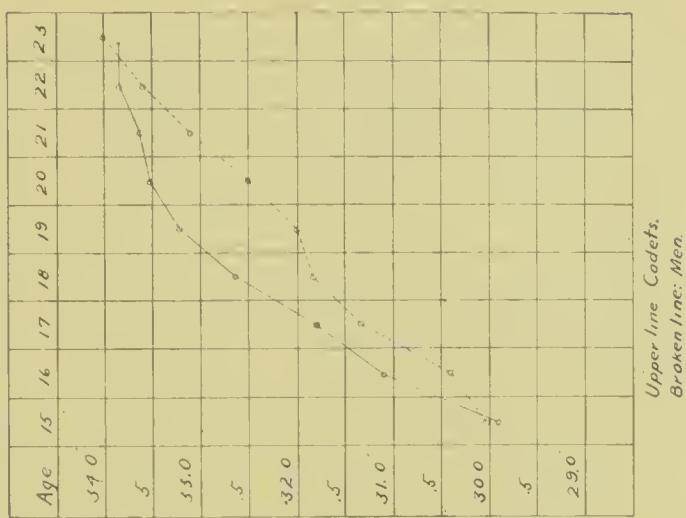
beginning with a difference in their favor of a little less than one inch.

When we follow them from the very beginning of their respective periods of training — that is, from their fifteenth year on upwards — we find that the cadets rapidly gain over the apprentices and pass ahead of them in all three dimensions until they arrive at the eighteenth and nineteenth year. Here a marked change occurs. The apprentices slowly gain on the cadets in weight and chest circumference and actually pass them at the twenty-third year, while in height the cadets keep permanently in the lead and finish at the twenty-third year with a difference in their favor of two inches. These relations are seen more strikingly represented in the adjoining three charts.

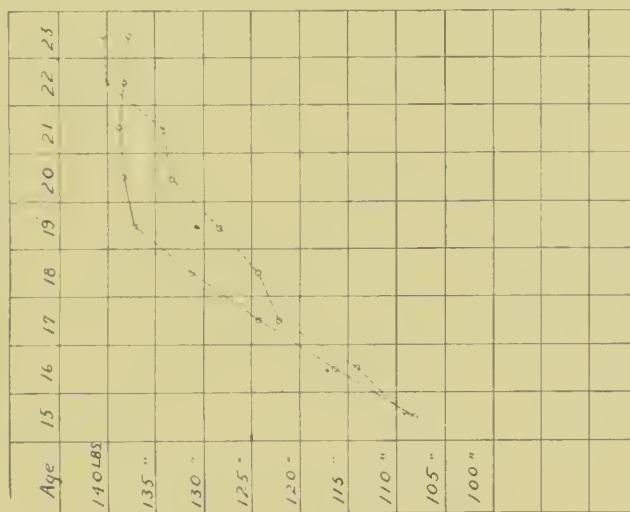
From the facts brought out in the foregoing study we may conclude: (1) That a high percentile rank in height, weight, and chest circumference, in growing children, is nearly always found associated with a superior grade of mental work, as that is determined ordinarily in our schools. (2) That the relationship between physique and mental ability is such that the training of the one will indirectly and favorably influence the growth and development of the other, when the training of either is kept within physiological limits.

LITERATURE.

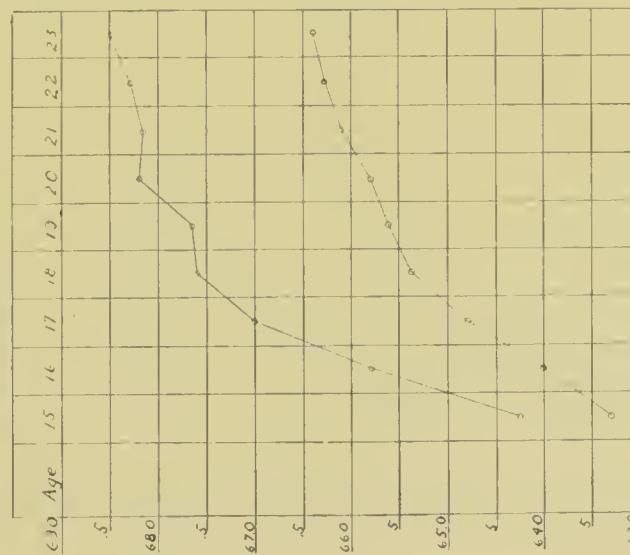
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III Mean Chest Cir Compared.

Upper line: Cadets.
Broken line: Men.

III Mean Weights Compared.

Upper line: Cadets.
Broken line: Men.

I Mean Heights Compared.

Upper line: Cadets.
Lower line: Men.



